

REMARKS

The Office Action of December 31, 2002 has been received and its contents carefully considered.

The Office Action Summary states that the drawings filed on December 11, 2000 have been accepted. The Examiner, however, has attached a Form PTO-948 that sets forth a number of drawing informalities with respect to Figure 4. In response, applicants enclose a Submission of Drawings with a corrected drawing for Figure 4.

Claims 1-10, 13-16 and 22 have been rejected under the second paragraph of 35 U.S.C. § 112 as indefinite.

The Examiner sets forth numerous reasons for this rejection. Applicants discuss each of these reasons below.

(a) The Examiner states that the phrase “measuring infrared absorption intensity at an infrared wave number...” that appears in claims 1 and 22 is not clear. The Examiner states that he cannot determine which IR intensity is being measured. That is, the Examiner cannot determine whether the IR intensity of ammonia, or of water, or of both is being measured.

In response, applicants point out that claims 1 and 22 each contain two measuring steps. What is being measured in the first measuring step is the infrared absorption intensity of the reference gas (gaseous phase moiety), and what is being measured in the second measuring step is the infrared absorption intensity of the sample. Claims 1 and 22 did not specifically state that what is being measured in the first measuring step is the infrared absorption intensity “of the reference gas”. Accordingly, applicants have amended claims 1 and 22 to insert this phrase in

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appln. 09/732,712

the first measuring step, so that these claims 1 specifically state that the infrared absorption intensity of the reference gas is measured in the first measuring step.

(b) With respect to the second measuring step, claims 1 and 22 recited that what is being measured is the infrared absorption intensity of water. Claims 1 and 22 also referred to the “measured intensity of the sample”, which is consistent with the above discussion that what is being measured is the infrared absorption intensity of the sample. Claims 1 and 22 thus appeared to be employing different terms for describing what is being measured in the second step. Accordingly, applicants have further amended claims 1 and 22 by changing the term “water” in the second measuring step to “the sample”.

In summary, there are two measuring steps in claims 1 and 22. In the first measuring step, a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less is employed as a reference gas. In the first step, the infrared absorption intensity of the reference gas is measured. In the second step, the infrared absorption intensity of the sample is measured. Applicants have amended claims 1 and 22 to further clarify these points.

(c) The Examiner states that it is not clear from the claims what is the difference between “a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less” serving as a reference gas and “ammonia as a sample”. These terms appear in claim 1.

In response, in claim 1, the term “ammonia as a sample” refers to the ammonia whose water concentration is to be determined, whereas the “gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less” serving as a reference gas refers to a reference gas whose infrared absorption intensity is used as the background of the infrared spectroscopy in measuring the infrared absorption intensity of a sample.

In claim 22, the term “ammonia as a sample” is one portion of the phrase “a gas vaporized by heating liquefied ammonia as a sample”. In claim 22, the infrared absorption intensity of the vaporized gas is measured in the cell.

(d) The Examiner asks whether the reference gas contains exact and known amounts of water. The Examiner asks that if the reference gas does not contain exact and known amounts of water, how can it be a reference gas?

In response, since the reference gas is a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less, the amount of water in the gaseous phase moiety will be very small and can be considered to be negligible relative to the water concentration of the object to be measured and can be ignored and, therefore, the gaseous phase moiety of liquefied ammonia can serve as a reference gas.

The Examiner seems to doubt that the reference gas, with the exact amount of water being unknown, can be used as a reference gas. However, a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less, whose amount of water is so small to be ignored, can serve as a reference gas.

(e) The Examiner asks what is “ammonia as a sample”. The Examiner asks whether it is liquefied ammonia or a gas.

In response, the “ammonia as a sample” in claim 1 refers to a sample of ammonia whose water concentration is to be determined, and this ammonia sample can be either liquefied ammonia or a gas. When the sample is liquefied ammonia, it is first vaporized, and it is the vaporized portion of the liquefied ammonia that is introduced into the optical cell for

measurement. When the sample is ammonia gas to begin with, then the ammonia gas is introduced directly into the optical cell.

In claim 22, as discussed above, the term “ammonia as a sample” is one portion of the phrase “a gas vaporized by heating liquefied ammonia as a sample. In claim 22, the vaporized gas is introduced in to the cell and the infrared absorption intensity of the vaporized gas is measured.

(f) The Examiner asks what does the expression “at which infrared absorbances of ammonia and water do not overlap as background absorption” mean. The Examiner asks what is the “background absorption” in this case.

In response, the term “background absorption” refers to the absorption of ammonia containing no water (or much less water than the water that is contained in the sample). In the present invention, the infrared absorption intensity of the reference gas is measured and used as backgrounds of the infrared spectroscope.

With respect to the phrase “at which infrared absorbances of ammonia and water do not overlap”, this refers to wave numbers at which there is an infrared absorption intensity for water, but not for ammonia, and at which wave number(s) measurement of water concentration is conducted.

The Examiner states that usually the term “background absorption signal” is referring to a signal that is not measured, but rather is subtracted from the spectrum of a mixture of an interfering compound and an analyte in order to obtain the absorption of the analyte. The Examiner states that since, in the present case, the analyte is water, it is not clear what is meant by overlapping both signals “as background absorption”.

In response, in the present invention, a gaseous phase moiety of ammonia containing no water (or much less water than the water the sample contains) is used as a reference gas. The infrared absorption intensity of the reference gas is measured and used as a background. The background value is subtracted from the infrared absorption intensity value obtained in measurement of a sample. The resulting value is the infrared absorption intensity of water in the sample ammonia.

Moreover, by comparing the infrared absorption spectrum of ammonia with that of water, wave numbers at which there is an infrared absorption intensity for water but not for ammonia can be selected. In the present invention, the wave number(s) is/are used in measuring the infrared absorption intensity of the reference gas, and the infrared absorption of the reference gas as a background value is subtracted from the infrared absorption intensity of the sample.

(g) The Examiner states that the term “measured intensity of the sample” in the last subparagraph of the claim is not clear. The Examiner asks what is the meaning of this term. The Examiner asks how can the sample have intensity. The Examiner asks whether this is a measured intensity of the absorption signal of water or something else.

In response, the term “measured intensity of the sample” refers to the infrared absorption intensity of ammonia containing water at selected wave numbers, from which the background infrared absorption intensity is subtracted in order to obtain a precise value of the infrared absorption intensity of water contained in the ammonia.

(h) The Examiner asks which component is being referred to in the last sentence of the claim in the phrase “the background absorption intensity”.

In response, the term “the background absorption intensity” in the last sentence of claims 1 and 22 refers to the infrared absorption intensity of the reference gas. Applicants have amended claims 1 and 22 to add the phrase “of the reference gas” in this sentence.

(i) The Examiner states that claim 22 is unclear as to what is being measured and what is being used as a reference gas.

In response, what is being used as a reference gas in claim 22 is the gaseous phase moiety of liquefied ammonia.

Further, what is being measured in claim 22 is the infrared absorption intensity of a gas that is formed by vaporizing liquefied ammonia, with the liquefied ammonia being the sample whose water content it is desired to determine and having a water concentration of 10 ppm or less.

(j) The Examiner points out that claim 1 recites “introducing a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less as a reference gas”. The Examiner further states that claim 22 recites “measuring a water concentration in ammonia having a water concentration of 10 ppm or less”, wherein as the first step the “gaseous phase moiety of liquefied ammonia” is introduced as a reference gas. The Examiner asks how these two gases differ, that is, how is the gas that is measured different from the gas that is used as a reference gas.

The Examiner’s question is somewhat confusing since he refers to claims 1 and 22, and apparently is interpreting certain phrases that appear in claim 22 based on his interpretation of different phrases in claim 1. Applicants believe the Examiner is asking how does the reference gas in claim 22 differ from the ammonia that is being measured in claim 22.

Applicants first note claim 22 has been amended to state that the reference gas is a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less.

In claim 22, the object to be measured is liquefied ammonia having a water concentration of 10 ppm or less. The total amount of the liquefied ammonia to be measured is vaporized and introduced into the optical cell at a constant flow rate. The reference gas used in the measurement is, as in claim 1, a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less.

(k) The Examiner states that since the term “a gaseous moiety of liquefied ammonia” is not defined in the specification in clear and unambiguous terms, and it is not clear if this is a gas of crude ammonia, or refined gas, or a gas containing a known amount of water, or an unknown of water, or a negligible amount of water, he is interpreting this term in its broadest meaning, that is, as any ammonia gas obtained from liquefied ammonia which contains less than 10 ppm of water.

In response, in the present invention, liquefied ammonia whose gaseous phase moiety is used as a reference gas in the measurement is purified to the same level as or higher than the purity of the ammonia whose water concentration is to be determined in the measurement.

The water concentration in the reference gas may be known or as small as ignorable in comparison with the water concentration in ammonia which is the object to be measured. A gaseous phase moiety of liquefied ammonia having a water concentration of 10ppm or less can be used as a reference gas as described in claim 22, even though the water concentration in the reference gas is unknown.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appln. 09/732,712

In view of the above, applicants submit that the claims comply with the requirements of the second paragraph of 35 U.S.C. § 112 and, accordingly, request withdrawal of this rejection.

Claims 1-10 and 22 have been rejected under 35 U.S.C. § 103(a) as unpatentable over two articles by Wu et al, one being the article in Analytic Chemistry that the Examiner previously employed to reject the claims, and the other being the article in J. J. Appl. Phys.

Applicants submit that Wu et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

The present invention, in one aspect as set forth in claim 1, is directed to a method for measuring a water concentration in ammonia, comprising (a) introducing a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less as a reference gas into a multi-reflection long optical path cell, (b) measuring infrared absorption intensity of the reference gas at an infrared wave number at which infrared absorptions of ammonia and water do not overlap as background absorption, (c) introducing the ammonia as a sample at a constant flow rate into the cell, (d) measuring infrared absorption intensity of the sample at the infrared wave number, and (e) obtaining the water concentration based on the measured intensity of the sample and the background absorption intensity of the reference gas with a water concentration calibration curve prepared in advance.

Claim 1 recites that two measurements are made, one of the reference gas to provide a background absorption intensity and the other of a sample whose water concentration is to be measured, and states that both measurements employ an infrared wave number. Claim 1 further states that a gaseous phase moiety of liquefied ammonia is employed as the reference gas.

In another aspect, and as set forth in claim 22, the present invention provides a method for measuring a water concentration in ammonia having a water concentration of 10 ppm or less, comprising (a) introducing a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm as a reference gas into a multi-reflection long optical path cell, (b) measuring infrared absorption intensity of the reference gas at an infrared wave number at which infrared absorbances of ammonia and water do not overlap as background absorption, (c) introducing a gas vaporized by heating liquefied ammonia as a sample at a constant flow rate into the cell, (d) measuring infrared absorption intensity of the sample at the infrared wave number, and (e) obtaining the water concentration based on the measured intensity of the sample and the background absorption intensity of the reference gas with a water concentration calibration curve prepared in advance.

Wu et al disclose a method for measuring trace moisture in ammonia, wherein a “near-infrared” wavelength is employed. The wavelength described in Wu et al is 1371nm (page 3316, right column, lines 6-8) corresponding to a wave number 7294cm^{-1} . See also, page 3317, left column, where Wu et al describe the use of a “near-infrared” InGaAsP DFB laser emitting at 1371nm. On the other hand, the present invention, as set forth in claims 1 and 22, measures “infrared absorption intensity”, not “near-infrared” absorption intensity. Thus, “an infrared wave number” is employed in the present invention and wavelengths used in the present invention fall within the infrared region (2,500 to 50,500nm, corresponding to a wave number 200 to $4,000\text{cm}^{-1}$), which are quite different from the wavelength used in Wu et al.

However, as the present inventors mention in the “Background Art” section at page 3, last paragraph of the present specification, in the past, in infrared spectrometry, the absorptions

by ammonia and the absorptions by water cannot be easily separated even if the former are weak because such an absorption by ammonia is present near the absorption by water in many cases. The present invention is to solve a problem remaining in conventional methods that results because trace moisture quantitative analysis has a large margin of error.

The Wu et al disclosure at page 3316, left column, does not disclose a measuring of a reference gas and a measuring of a sample, and does not disclose that the reference gas is a gaseous phase moiety of liquefied ammonia. Accordingly, this disclosure of Wu et al does not anticipate the presently claimed invention.

The infrared spectrometry method for measuring a water concentration in ammonia described in the present invention requires an ammonia gas containing a negligible water content as a reference gas, while the Wu et al articles describe using a specific wavelength only, but do not describe using such a reference gas at all. The present invention, which can solve problems in conventional infrared spectrometry methods, was not anticipated by the descriptions in the Wu et al references of the use of wavelengths near the wavelength used in the present invention and/or use of similar measurement cells.

The Examiner has relied on the disclosure at page 3320, under the heading "Calibration of H₂O in NH₃", which, according to the Examiner, discloses the use of reference gases containing, respectively, 110ppb, 245ppb, 523ppb water content. However, the use of these gases in Wu et al is quite different from the use of the reference gas in the present invention. In Wu et al, the three gases having different water contents are used for establishing a calibration curve. Also, in the measuring method of the present invention, gases having a certain water content similarly are used for producing a calibration curve, but are not employed as a "reference

The present invention uses a reference gas (an ammonia gas containing a negligible water content) in order to refer to the minute amount of moisture contained in the ammonia gas as a background measurement at the wavelength.

Moreover, the Wu et al measurements with the gases containing 110, 245 and 523 ppb of H₂O were made with a laser wavelength of “1370.93 to 1370.99nm”, as disclosed at page 3320, left-column, lines 15 to 17, which as discussed above is a “near-infrared” wavelength, and is quite different from the infrared absorption intensity that is measured in the present invention.

Moreover, the method of Wu et al obtains absorption spectra of 110, 245 and 523ppb water in NH₃ by adding water vapor to “pure NH₃” passed through a purifier. However, it is not clear whether the moisture in the ammonia gas in Wu et al is sufficiently removed by the purifier since the water concentration within the trace moisture measurement region cannot be determined at all. Since Wu et al do not teach measuring the concentration of water in the “pure NH₃” obtained through a purifier, the zero point in the Wu et al calibration curve is not determined. Therefore, it is clear that values in the Wu et al curve purportedly calibrated by adding water at a certain concentration contain noise, and such a method can only obtain results with low reproducibility.

The present invention is based on the present inventors’ finding, described at pages 11 and 12 of the present specification, that the water concentration distributed to the gaseous phase of the liquefied ammonia is as low as a range of from one-tenth to one-hundredth of the water concentration in the liquid phase, and as described in the present specification, the present invention can use as a reference gas the gaseous phase of liquefied ammonia whose slight water content in the liquid phase falls within the measurable range detectable by a known method. Use

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appln. 09/732,712

of such a reference gas is not described by Wu et al at all. The present claims recite the use of the gaseous phase of liquefied ammonia, and are not disclosed or suggested by Wu et al.

With respect to claims 3 and 4, the Examiner recognizes that Wu et al do not disclose the wave numbers recited in claims 3 and 4, and does not disclose vaporizing liquefied ammonia to obtain ammonia as recited in claim 5. The Examiner argues that it would have been obvious to find other IR ranges and use them in the process of Wu et al where the water absorption signals would not overlap with the ammonia absorption signal. The Examiner also argues that it would have been obvious to vaporize liquefied ammonia to obtain ammonia gas because ammonia is transported and stored in liquefied form.

Claims 3 and 4 depend from claim 1. Accordingly, applicants submit that these claims are patentable for the same reasons as discussed above in connection with claim 1.

Further, with respect to the Examiner's argument that it would have been obvious to find other IR ranges, applicants submit that Wu et al do not contain any teaching or suggestion that would lead one ordinary skill in the art to the recited ranges. Applicants point out that Wu et al, at page 4788, right-hand column, of J.J. Appl. Physics, state that information regarding NH₃ absorption in the near-infrared region is rather limited. Wu et al, in the left hand column of page 4788, state that trace moisture measurement in NH₃ is more difficult than in N₂ because NH₃ is not transparent and has many absorption bands that interfere with H₂O absorption lines from the near infrared to the mid-infrared spectral region. Wu et al, at page 4790, in discussing a single-cell system that they employed, state that this is an example where the detection of trace gas is apparently hindered by the interference absorption lines of the matrix gas, and that such a situation is considered to be unavoidable in the near-infrared region, since in this spectral region,

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appln. 09/732,712

lines, and that the use of the dual cell configuration is apparently essential for the trace moisture detection in NH_3 with high sensitivity.

Thus, Wu et al teach away from the use of a single cell system, and nowhere teach or suggest the single cell system of the present invention with the IR ranges set forth in claims 3 and 4.

In addition, there is a wide overlap between ammonia and water absorbances, and it is impossible to obtain accurate results by only selecting a wavelength at which the absorbances do not overlap. In order to conduct accurate and reproducible measurement by an infrared spectrometry method, it is necessary to use as a reference gas an ammonia gas having a negligible water content, which Wu et al neither teach nor suggest.

The Examiner acknowledges that the arguments that applicants submitted in the previous Amendment Under 37 C.F.R. § 1.111 filed on November 4, 2002 with respect to the Wu et al article in Analytic Chemistry and the anticipation rejection were correct, and that the Wu et al article in Analytic Chemistry cannot be considered as anticipating the present invention.

The Examiner states, however, that he believes that the claims are obvious over the disclosures of Wu et al. The Examiner appears to be referring to both Wu et al articles.

First, the Examiner argues that Wu et al disclose a method of measuring traces of water in ammonia using a reference gas with less than 10 ppm of water, which according to the Examiner is exactly what is recited in the claims, except that Wu et al do not disclose the IR wavelengths employed in the present claims. The Examiner argues, however, that measurement of water and NH_3 in the ranges disclosed by applicants are well known in the art and, therefore, it

would have been obvious for one of ordinary skill in the art to modify the Wu et al method by measuring a water content in slightly shifted IR ranges.

With respect to the Examiner's comment that Wu et al disclose a method of measuring traces of water in ammonia using a reference gas with less than 10 ppm of water which, according to the Examiner, is exactly what is recited in the claims, applicants point out that claim 1 and 22 recite that the reference gas is a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm. Wu et al do not disclose or suggest that they employ a reference gas which is a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less. Accordingly, applicants submit that Wu et al do not disclose or suggest the subject matter of claims 1 and 22.

Further, applicants' point out that none of the prior art references teaches using the same IR ranges that are employed in the measuring method of the present invention such as defined in claims 3 and 4.

In addition, applicants point out that wave numbers at which there is an absorption intensity for water but not for ammonia can be determined, for example, by the following steps:

introducing nitrogen containing about 100 ppm of moisture and nitrogen containing about 100pm of ammonia into the optical cells, respectively,

the absorption spectrum for each of them is measured and the spectra are compared to each other to find ranges where ammonia and water signals do not overlap. This is a method generally employed in absorption spectroscopy.

Also, a method where the absorption intensity of the reference gas is measured and subtracted from the absorption intensity of the sample gas in order to obtain a value of the

absorption intensity derived from the object component (in the present invention, water) of the measurement is generally used, and Wu et al employ the method using a reference gas having a low water concentration for the near IR region.

However, the present invention is completed not only by conducting measurement at selective wave number (s) and using a reference gas having a low water concentration, but also by using a gaseous phase moiety of liquefied ammonia having a water concentration of 10ppm or less, which characterizes the invention.

The Examiner states that applicants have argued that “Wu...does not disclose a measuring of a reference gas”. The Examiner states that this argument is incorrect because at page 3319, in Figure 5, Wu et al disclose a “reference cell” for measuring a “reference gas”.

Applicants note that the statement that the Examiner refers to appears at page 6 of the Amendment that was filed on November 4, 2002, at lines 7 to 10. In this portion of the Amendment, applicants were specifically referring to the disclosure at page 3316, left hand column of the Wu et al article in Analytic Chemistry, where Wu et al refer to H₂O absorption lines at 1923.162 and 1922.342 cm⁻¹ that were employed in a prior art technique. In this portion of Wu et al, there is no mention of a reference gas.

Thus, the statement that was made in the Amendment is entirely accurate with respect to the prior art technique disclosed at page 3316 left column of Wu et al.

Further, although use of a reference gas is common to the present invention and Wu et al, there is a difference between the two in that Wu et al use at page 3319, in Figure 5, a dual cell system while the present invention employs a single cell system. Thus, in the present invention as set forth in claim 1 and 22, both the reference gas and the sample are introduced into the same

cell, whereas in Wu et al, two cells are employed, one for the reference gas and one for the sample. Wu et al do not disclose or suggest employing a single cell system in which the reference gas of the present invention and the sample are introduced.

Thus, with respect to the reference gas that the Examiner mentions in connection with Figure 5 and page 3319, Wu et al disclose a dual cell system comprised of a sample cell and a reference cell. A purified NH_3 gas is employed in the reference cell. In contrast, in the present invention, the same cell is employed for the reference gas and the sample. Applicants submit that Wu et al do not disclose or suggest at page 3319 such a technique with a reference gas of the present invention. Thus, Wu et al employ a dual cell system, whereas the present invention employs a single cell for both measurements.

Applicants note that Wu et al at page 3318, left hand column, in the last line of the first complete paragraph, do refer to a “normal method” of a single beam for detecting trace moisture in NH_3 , and state that if such a system were to be used, the linearity and sensitivity of the calibration curve could be lost in the low-concentration region. Applicants submit that one of ordinary skill in the art would interpret this disclosure to mean that Wu et al could not obtain the linearity and sensitivity of the calibration curve due to the significant background noise at a wave number where water absorbs infrared radiation when they used a reference gas in a single cell system. Further, as discussed above, Wu et al in J.J. Appl. Physics disclose that a single cell system cannot be employed when trace moisture detection in NH_3 with high sensitivity is desired. Moreover, as discussed above, We et al do not employ the reference gas of the present claims.

Further, the Examiner argues that since the present claims and specification do not provide a specific definition for the term “a gaseous phase moiety of liquefied ammonia”, the

Examiner takes the position that any type of ammonia gas obtained from liquefied ammonia can be considered “a gaseous phase moiety of liquefied ammonia”, especially since ammonia is usually transported in liquid form.

In response, with respect to the “gaseous phase moiety of liquefied ammonia” used as a reference gas in the present invention, only the gaseous phase is taken out from a container where the ammonia is a gas-liquid equilibrium, and introduced into the cell.

Physically, gaseous and liquid phases of ammonia can exist at equilibrium in a container, or only a gaseous phase of ammonia can exist in a container. Further, when gaseous and liquid phases of ammonia exist at equilibrium in a container, either one of the phases can be taken out from the container. In a case where the liquid phase is taken out, it may be heated to obtain ammonia in the form of gas. Although Wu et al describe introducing ammonia in the form of gas, they do not disclose how they obtain ammonia in the form of a gas.

In the Amendment filed on November 4, 2002, applicants argued, at page 7, that in the Wu et al method, “it is not clear whether the moisture in the ammonia gas in Wu et al is sufficiently removed by the purifier since the water concentration within the trace moisture measurement region cannot be determined at all”. Applicants made this argument in connection with the Wu et al disclosure of a method of obtaining absorption spectra of 110, 245 and 523 ppm water in NH_3 by adding water vapor to “pure NH_3 ” passed through a purifier. Applicants argued that since Wu et al do not teach measuring the concentration of water in the “pure NH_3 ” obtained through a purifier, the zero point in the Wu et al calibration curve is not determined, and that such a method can only obtain results with low reproducibility.

The Examiner asserts, however, that he does not have any grounds to doubt the accuracy of the Wu et al method.

In this connection, the Examiner asserts that applicants call the gases containing less than 10 ppm of water “ammonia gas containing negligible water content”. The Examiner points out, however, that Wu et al state at page 3319, left hand column, that the purified ammonia used in his method contains less than one ppb (10,000 times less) amount of water. The Examiner states that it is, in fact, a “zero point” for measurements of 110, 245 and 523 ppb of water in ammonia. The Examiner argues that the one-tenth amount of water in the gaseous phase relative to that in the liquid phase, which applicants state is achieved in the present invention, cannot be considered a “negligible amount” of water, and leads to at least a 10% error, if it is taken as a zero point. The Examiner states that he does not understand how it is possible to use a reference gas in the presently claimed method without knowing the quantities of the components of the reference gas.

In response, in Wu et al, ammonia purified with a purifier is used as a reference gas. Considering that the infrared absorption showed the linearity with the concentration when the water concentration is 110, 245 and 523ppb, the purified ammonia might have a water concentration which is sufficiently low as reference gas. However, with respect to performance of the purifier, Wu et al only describe that “the purifier could remove moisture in nitrogen below 1 ppb” at the left column of page 3319 of Analytical Chemistry, and do not mention how much moisture in ammonia can be reduced. Further, in the case of using ammonia purified with a purifier, depending on the water conditions of the purifier, the ammonia, even after purified with the purifier, might have too high a concentration of water to be used as a reference gas. On the other hand, the present invention uses an ammonia gas which does not require purification by a

purifier. Since the gas-liquid partition coefficient quantifying water content in the gaseous phase and liquid phase of ammonia at equilibrium is 1/100, the gaseous phase moiety of ammonia in the present invention always has an ignorably low water concentration, that is, one-hundredths lower than that of the liquid phase. The error in measurement of moisture content in ammonia is around 1%.

The Examiner states that applicants throughout their arguments have employed the term “an ammonia gas having a negligible water content”. The Examiner states that this terminology is confusing. The Examiner asks whether applicants mean that the water content is completely ignored when this gas is used as a reference gas. The Examiner states that the word “negligible” means that something is not taken into account, and asks whether that is the meaning in the present invention. The Examiner asks that, in other words, does the phrase mean that the reference gas, although containing less than 10 ppm of water, which by Wu et al is not considered a “negligible amount”, is regarded in the present invention as not containing water at all.

In response, by the term “a negligible water content” of the reference gas, applicants mean that, as described above, in ammonia having a water concentration of 10ppm or less, the water concentration of the gaseous phase moiety to be taken out from the gas-liquid equilibrium and used as a reference gas, is always one-hundredths lower than that of the liquid phase, which does not affect the function of the reference gas at all.


In view of the above, applicants submit that the present claims are patentable over Wu et al and, accordingly, request withdrawal of this rejection.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appln. 09/732,712

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

Respectfully submitted,

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AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appln. 09/732,712

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

The claims are amended as follows:

1. (Twice amended) A method for measuring a water concentration in ammonia, comprising:

introducing a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less as a reference gas into a multi-reflection long optical path cell,

measuring infrared absorption intensity of the reference gas at an infrared wave number at which infrared absorptions of ammonia and water do not overlap as background absorption,

introducing the ammonia as a sample at a constant flow rate into the cell,

measuring infrared absorption intensity of the sample ~~water~~ at the infrared wave number, and

obtaining the water concentration based on the measured intensity of the sample and the background absorption intensity of the reference gas with a water concentration calibration curve prepared in advance.

22. (Amended) A method for measuring a water concentration in liquefied ammonia having a water concentration of 10 ppm or less, comprising

introducing a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less as a reference gas into a multi-reflection long optical path cell,

measuring infrared absorption intensity of the reference gas at an infrared wave number at which infrared absorbances of ammonia and water do not overlap as background absorption,

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appln. 09/732,712

introducing a gas vaporized by heating liquefied ammonia as a sample at a constant flow rate into the cell,

measuring infrared absorption intensity of ~~water~~ the sample at the infrared wave number, and

obtaining the water concentration based on the measured intensity of the sample and the background absorption intensity of the referenced gas with a water concentration curve prepared in advance.